Attachment 1
Monitoring Well Installation Work Plan Narrative

DRAFT WORK PLAN

BOREHOLE DRILLING, WELL INSTALLATION, WELL DEVELOPMENT, AND OTHER SUPPORT SERVICES GROUNDWATER INVESTIGATION IN PAVILLION, WYOMING

CONTRACT NO. EP-C-08-034

Prepared for:
U.S. Environmental Protection Agency
National Risk Management Research Laboratory
Ground Water and Ecosystem Restoration Division
Ada, Oklahoma

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PROJECT NO. 135976
APRIL 2010

WORK PLAN

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Appendix D Waste Management Plan

LIST OF ACRONYMS

ASTEM	American Society for Testing and Materials
bgs	below ground surface
EPA	U.S. Environmental Protection Agency
EZ	exclusion zone
FADL	field activity daily log
HASP	health and safety plan
ID	inside diameter
POC	point of contact
PPE	personal protective equipment
PVC	polyvinyl chloride
QAPP	quality assurance project plan
Shaw	Shaw Environmental and Infrastructure, Inc.

1.0 INTRODUCTION

This work plan is being executed for the U.S. Environmental Protection Agency (EPA) National Risk Management Research Laboratory, Ground Water and Ecosystem Restoration Division, Contract Number EP-C-08-034, and Technical Directive 6FS400CS dated February 8, 2010. EPA has tasked Shaw Environmental and Infrastructure, Inc. (Shaw) with performing field activities associated with the borehole drilling, downhole logging, monitoring well installation and development, well surface completion, and the management of investigation derived waste. Monitoring well sampling is not included in the technical directive scope of work. The monitoring wells are being installed in the vicinity of Pavillion, Wyoming. This work plan and supporting appendices present the technical approach for the successful completion of the technical directive.

1.1 PROJECT LOCATION AND BACKGROUND

Pavillion, Wyoming, is a town of approximately 165 residents, located on the Wind River Indian Reservation in the middle of the Wind River Basin. Pavillion is approximately 25 miles northwest of Riverton. Potable water is supplied by private wells that are typically screened several hundred feet below ground surface (bgs). Recently, there have reports of methane in several of these private wells. The monitoring wells will be installed in residential and/or semi-rural areas in and around Pavillion for EPA to investigate potential sources of the increased methane. Discussions with local well drillers in the Pavillion area indicated the methane is typically first encountered in a "second" sand layer at approximately 350 to 400 feet bgs.

1.2 SCOPE OF WORK

In accordance with the technical directive, Shaw will provide professional services and resources necessary to install up to three deep (800 feet) and up to three shallow (250 feet) monitoring wells. Borehole drilling also includes downhole geophysical logging and coring. The number and depth of the proposed wells will be determined based on time constraints. The fieldwork must be completed by June 28, 2010 and within EPA funding levels. Fieldwork is scheduled to start the week of May 17, 2010 and continue through June 28, 2010. The monitoring well order (priority) will be specified by EPA.

Technical directive required tasks include the following:

- Preparation of this work plan,
- Preparation of a quality assurance project plan (QAPP) and health and safety plan (HASP)

- Mobilization of the needed equipment, materials, and work force (including subcontractors) to commence and sustain this field effort and meet the schedule requirement.
- Site preparation, which includes identifying below-ground and overhead utilities; clearing, grubbing, and grading the site to allow unobstructed access to the borehole location; and securing the site from inadvertent intrusion
- Advancing up to three deep and three shallow boreholes to the desired depth and logging the borehole based on drill cutting and coring
- Open borehole geophysical logging
- Monitoring well installation
- Monitoring well development
- Surface completion
- Management of investigation-derived waste, including the packaging, transportation, and disposal of drilling mud and borehole cuttings and well development purge water.
- Site restoration
- Demobilization
- Preparation of a data package/completion report.

1.3 PROJECT SCHEDULE

The proposed baseline activity-specific timeline, critical path, and Gantt chart are presented in Appendix A. Because of the relatively short activity durations, this schedule will be used to status field activity performance weekly and report technical directive performance monthly.

1.4 WORK PLAN ORGANIZATION

The remainder of this work plan is organized as follows:

- **Section 2.0:** Project Planning and Organization
- **Section 3.0:** Project Activities
- **Appendix A:** Project Schedule.
- **Appendix B:** Site Health and Safety Plan
- **Appendix C:** Quality Assurance Project Plan
- **Appendix D:** Waste Management Plan.

2.0 PROJECT PLANNING AND ORGANIZATION

Project planning includes the assembly of the project team and preparation of the required field plans. In addition, specialty subcontractors, equipment and materials are procured. Plans include this work plan, QAPP, HASP, and waste management plan. Other pre-field documents include the preparation of technical specifications for the Drilling/Well Installation and Downhole Logging Request for Bids.

2.1 PROJECT TEAM

A Shaw project team has been assembled, with the field operations team based on the geographically nearest available resources. Key Shaw personnel are summarized in Table 2-1. In addition, various subcontractors and vendors will be used to supply specialty services and materials needed for project completion.

Table 2-1 Shaw Project Team Personnel

Project Title	Name	Contact Information
Program Manager	Sujith Kumar	Shaw Environmental and Infrastructure, Inc. US EPA RSKERC 919 Kerr Research Drive P. O. Box 1198 Ada, Oklahoma 74820 (580) 436-8768 Kumar.Sujith@epamail.epa.gov
Program Contracting Officer	Karen Johnson	Shaw Environmental and Infrastructure, Inc. Contract Administration and Procurement Business Management 5050 Section Avenue Norwood, Ohio 45212-2025 (513) 782.4674 Karen.Johnson@shawgrp.com
Technical Directive Manager	Lowell Wille, PMP, P.G.	Shaw Environmental and Infrastructure, Inc. Applied Science and Engineering 312 Directors Drive Knoxville, TN (865) 694-7394 Lowell.Wille@shawgrp.com
Drilling Technical Lead	Tom McCrory, P.G.	Shaw Environmental and Infrastructure, Inc. 2440 Louisiana Boulevard NE, Suite 300 Albuquerque, NM 87110 (505) 412-9527 Thomas.Mccrory@shawgrp.com

Project Title	Name	Contact Information
On-Site Supervisor		
QC Project Lead	Tom McCrory, P.G.	Shaw Environmental & Infrastructure, Inc. 2440 Louisiana Boulevard NE, Suite 300 Albuquerque, NM 87110 Cell: (505) 412-9527 Thomas.mccrory@shawgrp.com
Health and Safety Specialist		
Waste Management Project Specialist		
On-Site Representatives Project Geologists	Saeed Haider, P.G. James Wilson, P.G. Trenton Richards, P.G.	Various

2.2 PERSONNEL DUTIES AND RESPONSIBILITIES

Program Manager - The Shaw Program Manager has oversight and management responsibilities for all program activities under the Contract Number EP-C-08-034. The Program Manager is the senior manager responsible for implementation of Technical Directive 6FS400CS requirements, and the principal point of contact (POC) with EPA. While the Technical Directive Manager is responsible for the day-to-day activities associated with individual technical directive, the Program Manager ensures all contract and technical directive requirements are being met. The Program Manager monitors program costs and approves the technical directive budget and schedules. All change requests are process through the Program Manager.

Program Contract Officer - The Shaw Program Contract Officer ensures all program-related activities are in compliance with the contract terms and conditions (Contract Number EP-C-08-034) and all technical services and documents comply with the technical directive statement of work. The Program Contracts Officer is the POC for all contract-related questions and issues. The Program Contracts Officer assists the Program Project Manager and Technical Directive Managers stay compliant with all applicable Federal Acquisition Regulation requirements. The Program Contacts Officer assists the Technical Directive Managers prepare request for bid packages and ensure the required flow down provisions are included in all subcontracts.

Technical Directive Manager - The Technical Directive Manager is responsible for the execution of technical directive requirements (Technical Directive 6FS400CS). The Technical Directive Manager works with the Program Manager and Program Contracts Officer to ensure all program related activities are in compliance with the contract terms and conditions (Contract Number EP-

C-08-034) and all technical services and documents comply with the technical directive statement of work. While the Program Manager is the POC with EPA, the Technical Directive Manager discusses specific related technical directive and technical issues with EPA. The Technical Directive Manager is responsible for managing all day-to-day activities (including subcontractor, vendors, and suppliers) related to the technical directive. The Technical Directive Manager is responsible for monitoring technical directive performance, including cost and schedule adherence.

Drilling Technical Lead – The Drilling Technical Lead is responsible for compliance with the monitoring well installation-related technical scope of work contained in Technical Directive 6FS4000CS. The scope of work activities include the advancement for the boreholes to their desired depth, including geologic logging the borehole and rock coring, borehole geophysical logging, monitoring well construction, and development and waste management related activities. The Drilling Technical Lead is the principal POC for the On-Site Supervisor concerning site logistics and monitoring well installation related issues. The Drilling Technical Lead will be consulted to determine well completion criteria based on borehole cuttings, coring, geophysical logging, and other field information.

On-Site Supervisor – The On-Site Supervisor is responsible for the day-to-day operations of the field effort. The On-Site Supervisor directly oversees all field-related activities, including technical direction to subcontractors and vendors. The On-Site Supervisor works closely with the Waste Management Specialists to ensure all waste generated is properly stored and labeled prior to characterization and transportation from the site(s). This includes waste generated at the monitoring well sites and temporary equipment decontamination facility.

The On-Site Supervisor will maintain a logbook or keep a field activity daily log (FADL) to record all site wide activities not captured on individual site FADLs. The On-Site Supervisor will review the individual site FADLs for accuracy and completeness and initial and date them. The On-Site Supervisor will review the subcontractor daily logs for accuracy and completeness, and is required to sign and date them.

Because of the short duration of the field activities, a full-time quality assurance and waste management specialists will not be on site full time. When these individuals are not on site, their respective duties and responsibility will be assumed by the On-Site Supervisor.

Health and Safety Specialist – The Health and Safety Specialist works closely with the On-Site Supervisor, Drilling Technical Lead, and Technical Directive Manager to provide overall site health and safety site support. This is a full-time site position and this individual is required to be on site whenever work activities are occurring. Because there is not a full-time Quality Control

Specialist assigned to the project, the Health and Safety Specialist is responsible for the environmental monitoring required to occur. This monitoring can be delegated to the On-Site Representative (Project Geologist). The Health and Safety Specialists will perform the initial site safety awareness training, inspect all equipment that arrives at the site, perform the daily safety tailgate briefings, and maintain the safety records, including site specific training records. If necessary, site-specific refresher training will be performed. The Health and Safety Specialist is the POC for the project team for any safety-related issues or concerns. The Health and Safety Specialist will maintain a site log or FADL to record safety-related activities not recorded on the sitewide or site-specific log or FADL.

The Health and Safety Specialist will observe site activities to ensure compliance with the health and safety plan and associated general safety requirements and identify potential safety concerns. The Health and Safety Specialist will make periodic inspections of the work site to ensure the equipment and work force is complying with established requirements.

Waste Management Specialist – The Waste Management Specialist works closely with the On-Site Supervisor, Drilling Technical Lead, and Technical Directive Manager and provides overall support to site waste management and logistical issues concerning waste generation, storage, waste characterization (sampling), transportation, and disposal. The Waste Management Specialist is the POC between project team and the transportation subcontractor and disposal facility. The Waste Management Specialist ensures that the waste is properly stored after generation and characterized based on the disposal facility's waste acceptance criteria. The Waste Management Specialists specifies how the waste will be stored and transported to be complaint with applicable regulations and requirements. The Waste Management Specialists inspect material storage areas to ensure all hazardous and nonhazardous materials are properly stored prior to their use, including fuels and other hydrocarbons such as oils and hydraulic fluid. The Waste Management Specialist will maintain a site log or FADL to record waste management-related activities not recorded on the sitewide or site-specific log or FADL.

On-Site Representative (Project Geologist) – A Project Geologist will be assigned each major activity site, such as each drilling rig and well development rig. The Project Geologist will be responsible for the activities associated with each assigned activity. The Project Geologist is responsible for the technical, quality, and safety-related activities that occur at their assigned location. The Project Geologist will maintain a logbook or FADL.

The Project Geologist will log the boring based on drill cutting and/or rock cores, track quantities consumed such as drilling mud, well screen and casing lengths, and zones of fluid loss. The Project Geologist will review the borehole logging results and compare them to the boring logs for representativeness. If delegated by the Health and Safety and Waste Management Specialists,

the Project Geologist will perform the required environmental monitoring (including drilling mud measurements) and waste management compliance activities at the work site. All monitoring measurements will be recorded on the appropriate form(s).

The Project Geologist will work closely with the On-Site Supervisor and subcontractor personnel to ensure the work scope is execute according to this work plan, the QAPP, HASP, the technical directive scope of work, and other project objectives. The Project Geologists will also perform health and safety and quality oversight at their individual drilling locations.

2.3 MEETINGS AND REPORTS

Progress meetings will be held with site personnel as requested by EPA. Because of the short duration of the field effort, it is assumed that regular status meetings (such as monthly) will not be effective. Field documents will be posted to the project SharePoint site so they are available to EPA and off-site project team members. A daily site report, including health and safety, quality, waste management, and subcontractor performance, will be prepared and posted to the project SharePoint site. The original hard copy of these reports and all supporting field records, will be maintained at the site and transferred to the project files at the conclusion of the field effort. The original of all field records will be maintained at the project site and transferred to the project files at the conclusion of the field effort.

3.0 PROJECT ACTIVITIES

3.1 PRE-CONSTRUCTION SUBMITTALS

The following plans have been developed for this technical directive and are to be considered as complementary components to this work plan.

- Appendix B HASP
- Appendix C QAPP
- Appendix D Waste Management Plan.

3.2 PERMITS

The project team will comply with all applicable permits and requirements contained in the technical directive work scope.

The Wyoming One-Call system, which typically employs one or more private utility locating firms to identify and mark any public underground utility at the site, will be notified. As necessary, Shaw will work with local utility locators and residents to identify and mark all known private utilities potentially within the work zone.

As the project area has been designated a Comprehensive Environmental Response, Compensation and Liabilities Act site, EPA has made the determination that well permits are not required. The Wyoming State Engineer ruled in January 2007 that monitoring wells less than 4 inches in diameter and not used for water supply do not require permits. EPA has completed property access agreements with private individuals and local municipalities for access to the monitoring well sites. As necessary, the Technical Directive Manager will assist EPA in interfacing with county, the State of Wyoming, and other federal officials concerning this investigation.

3.3 PROCUREMENT

Upon approval of budget and schedule associated with Technical Directive 6FS400CS, Shaw will finalize procurement of equipment, materials, and subcontractors necessary for the execution the required scope of work. The anticipated subcontractor and vendors include the following:

Principal Subcontractors

- Drilling and Well Installation Services
- Downhole Logging Services.

Other subcontractors and service providers

- Utility Clearance (if necessary)
- Waste transportation
- General construction support (well and decontamination pad construction and site restoration
- Laboratory support services.
- Sand Draw Landfill (drilling mud and cuttings disposal)
- Riverton public owned treatment works to purchase water and for well development purge water disposal.

While Shaw can perform most of the work scope defined in the technical directive, local businesses will be utilized whenever feasible.

3.4 PRE-CONSTRUCTION MEETING AND ONGOING SUPPORT

As part of initial site mobilization, EPA and the Shaw on-site team will participate in a pre-construction meeting at or near Pavillion. If required, the subcontractor on-site leads and other appropriate subcontractors and organizations (local stakeholders) may also attend the meeting. The intent of this meeting will be to discuss technical directive strategies and finalize logistical issues prior to beginning. The Shaw on-site project team representatives include the Technical Directive Manager, On-Site Supervisor, Health and Safety Specialist, and Project Geologists. Others project team members that may attend include the Program Manager, Program Contracts Officer, and waste management specialist. The purpose of this meeting will be to:

- Confirm roles and responsibilities of key personnel and flow of communications for project execution.
- Review project schedule, sequence of tasks, and key milestones.
- Discuss key drilling, well completion and development and waste management strategies and requirements
- Prioritize monitoring well installation, including well locations and property access agreements.
- Identify local emergency responders, laydown area(s), and other necessary site support and logistics issues, such as water source and waste accumulation areas.

- Identify and discuss individual monitoring well issues, including traffic or resident inconveniences.

During the project, Shaw will support EPA's public outreach initiatives.

3.5 MOBILIZATION AND SITE PREPARATION

This task involves the accumulation and transportation to Pavillion, Wyoming, of the necessary equipment, tools, materials, supplies, and support equipment and personnel needed to initiate and sustain the technical directive scope of work. Because of the short duration of the field effort, a site trailer to accommodate the entire field team, including subcontractors, is not feasible. Shaw will have a travel trailer at the site that will provide a central rallying location for the field team and a shelter area to complete paperwork and store project files. The site instruments and a small quantity of supplies will be secured in this trailer.

This task also includes grading laydown areas and drill pads and temporary access roads, as necessary. A temporary equipment decontamination facility will be constructed. As required, plastic sheeting and berms will be placed around waste accumulation areas. In-ground mud pits will be installed during this activity, if required.

3.5.1 Mobilization

The equipment to be mobilized will depend on the finalized technical directive budget and schedule. It is anticipated that a minimum of two drill rigs will be required to install the deep and shallow wells. Depending on the well installation production rate, a third well development rig may be required. Other support equipment includes water truck(s) and flatbed (stake) truck(s) for transporting support equipment and supplies. A downhole geophysical logging trunk will mobilize to the site two to three weeks after drilling starts. The boreholes will be logged after the target depth is reached and prior to monitoring well installation.

Upon arrival at the site, each piece of equipment will be inspected to ensure that all appropriate safety devices, such as guards, safety switches and emergency cutoffs, are present, are in good working order, and can be safely operated. Each piece of equipment is required to have an operating fire extinguisher that will be readily accessible during all field activities. All equipment that enters the borehole or could contact equipment that

enters the borehole, will be decontaminated upon arrival at the site, between each bore hole, and before demobilizing from the site.

3.5.2 Site Locations and Utility Clearance

EPA has secured access permission from the respective property owner to each drilling location. While the general drilling location has been selected by EPA, the specific well location will be based on site logistics and equipment requirements. Shaw will work with the drilling subcontractor and EPA to select the exact monitoring well location.
Utility clearances will be performed at each monitoring well location.

3.5.3 Staging Areas and Site Security

Site control zones, including one or more exclusion zones (EZ) and a support zone, will be field designated as necessary by the On-Site Supervisor and Health and Safety specialist. These zones will be marked using caution tape. A brief description of each zone and its function follows:

- The EZs includes the designated drilling locations, temporary waste storage, and decontamination areas. The boundaries of the EZs are dynamic and will be expanded or reduced as dictated by activities during the project.
- The support zone consists of the temporary facilities, equipment laydown, and material staging areas, as needed. This is an uncontaminated area used to store materials.

Access to work areas containing health and safety hazards and/or potentially contaminated material will be limited to authorized personnel. All persons entering the work area will be required to sign in and out. Access may be denied to any individuals that have not completed the needed safety and site logistics briefings.

3.5.4 Temporary Erosion and Sediment Controls

Depending on the individual site layouts, erosion controls will be installed to prevent runoff into nearby drainage ways. Erosion controls will consist of straw bales and silt fencing and will be maintained until the conclusion of field work at each location. The controls will be inspected daily by the Project Geologist to ensure they have not degraded. Erosion controls will be installed according to Wyoming Natural Resources Conservation Service requirements.

Each area will be secured with security tape to prevent inadvertent intrusion.

3.5.5 Health and Safety Training

Upon arrival at the site but prior to any field activities, the Shaw Health and Safety Specialist will conduct an initial site- and activity-specific health and safety briefing. All on-site personnel are required to attend. This training will emphasize site specific safety issues and features designed to prevent incidents. It will also indicate the type(s) of personnel protective equipment (PPE) required for the various field activities.

Due to the possibility of encountering methane during drilling, the drilling subcontractor shall provide a brief explanation and demonstration of the blowout protection equipment and ensure that all on-site personnel are trained in its use. The driller will also do familiarity training of their equipment and identify potentially harmful features of the equipment, such as open rotating parts, and the location of emergency cutoff switches.

A daily safety tailgate briefing will be conduct at the beginning of each work shift and will last about 15 minutes. The meeting will include a safety topic, planned activities for the day (activity/job hazard analysis), and other site logistic issues.

3.6 DRILLING AND WELL INSTALLATION

3.6.1 Environmental Monitoring and Blowout Protection

The ambient air in the vicinity of each boring and the worker breathing zone will be monitored for explosive gases (methane), organic vapors, percentage of the lower explosive level, carbon monoxide, oxygen level, and hydrogen sulfide, if necessary. If dusty or windy conditions occur, monitoring for particulates may also be conducted (PM10). Borehole monitoring will be performed from initial borehole advancement until the completion of well development activities.

For the deep monitoring well drilling, each drilling rig will have installed blowout protection. The shallow wells will not require blowout protection, but the wells will be monitored for methane.

3.6.2 Site Preparation

For deep wells, a substantial volume of drill cuttings, mud, and other wastes will be

generated during drilling. The Project Geologist will establish and maintain an area to control these wastes prior to material characterization, transportation, and disposal.

The drill cuttings generated to install the conductor casing are considered nonhazardous but will be controlled, such as by placing them in a rolloff for temporary storage prior to testing and disposal.

The drill cuttings and fluids generated during mud rotary drilling will either be controlled within ground mud pits or portable mud pits. Mud pit design and layout will be based on site conditions and generally consist of two or more chambers to effectively settle out the drill cuttings prior to recirculating back down the hole. Shaker tables, sand pumps (cyclones), or other mechanical means may be used to separate the drill cuttings from the mud. If portable mud pits are used, they will have sufficient capacity to effectively support the drilling operations.

For the shallow wells, the fewer drill cuttings and mud are generated, and portable mud pits will be utilized. Because the shallow borings are not anticipated to encounter contamination (methane), the cuttings will be considered nonhazardous. The drill cutting will be shoveled from the temporary mud pit and either placed on the ground in a controlled manner or in containers.

3.6.3 Drilling

3.6.3.1 Unconsolidated Drilling and Conductor Casing

For the deep wells, a boring will be advanced through the unconsolidated alluvium until either competent material is reached or a depth of 100 feet, whichever comes first. The boring will have a large enough diameter that a 12-inch-diameter steel conductor (surface) casing can be installed. Drill cuttings generated by boring in the unconsolidated material will be considered uncontaminated and nonhazardous. These cutting will be segregated for sampling and disposal.

Once the competent or 100 feet bgs is reached, a conductor casing will be installed. If an adequate seal into the material cannot be made, the conductor casing will be cemented or grouted in place. The conductor casing can also used as the protective surface casing that extends approximately three feet above ground surface. The well protective casing will

follow American Society for Testing and Material (ASTM) D 5787, *Practice for Monitoring Well Protection.*

A conductor casing will not be required for the shallow wells.

3.6.3.2 Mud Rotary Drilling

Discussions with drilling contractors who have installed shallow and deep private water wells in the Pavillion area indicate that mud rotary drilling is the preferred drilling method. Following installation of the surface casing, a 10-inch-diameter tricone bit for the deep wells and an 8- inch-diameter tricone bit for the shallow wells will be advanced using standard mud rotary techniques. Drill collars and/or stabilizers will be used. Mud rotary drilling will follow standard industry practices and those presented in ASTM 5783, *Standard Guild for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for GeoEnvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices,* and ASTM D 6286, *Standard Guide for Selection of Drilling Methods for Environmental Characterization.*

The drilling mud with be water based with bentonite and/or polymer additives. Synthetic-based muds are not to be used. A mud mixer will be used to ensure the bentonite is adequately hydrated before being added to the mud pits and to eliminate "gumballs" that impede the mud's effectiveness.

During drilling operations, drill cuttings will periodically be collected, examined, and logged by the Project Geologist. Mud density will be periodically measured to ensure it remains less than 9 pounds per gallon. The mud density may vary based on subsurface conditions. Fluid loss will be monitored and noted in the boring log and field notes. If methane is detected, the mud density will be increased to prevent a blowout.

3.6.3.3 Rock Coring

Rock coring may be required for the screened interval in each borehole. For the deep borings, rock coring will likely be from approximately 780 to 800 feet. For the shallow borings, rock coring will likely be from approximately 240 to 250 feet. Depending on subsurface lithology anticipated or encountered during drilling, additional rock cores will be requested.

Rock coring will be performed following standard industry practices and those presented in ASTM D 2113, *Standard Practice for Rock Core Drilling and Sampling Rock for Site Investigations*, ASTM D 5079, *Standard Practices for Preserving and Transporting Rock Core Samples*, and ASTM D6169, *Standard Guild for Selection of Soil and Rock Core Sampling Devises Used with Drill Rigs for Environmental Investigations*. For these borings, standard "N" series (2-inch) rock cores will be retrieved from the borehole. Wireline core barrel will be used due to the anticipated coring depth. All rock cores will be placed in a local storage location for ultimate use by EPA.

3.6.4 Downhole Logging

Downhole geophysical logging will be performed between borehole completion and monitoring well construction in the open hole. At a minimum, the downhole logs will include a suite of resistivity tools (spontaneous potential, single-point resistance, and long and short normal resistivity tools), natural gamma and density (gamma-gamma) logs, and a caliper log.

Borehole logging will follow standard industry practices and those presented in the ASTM 5754, *Standard Guide for Planning and Conducting Borehole Geophysical Logging,* ASTM D 6274, *Standard Guide for Conducting Borehole Geophysical Logging – Gamma,* and ASTM D 6167, *Standard Guide for Conducting Borehole Geophysical Logging: Mechanical Caliper.*

The logging tools will be calibrated according to manufacturer's specifications. "Shop" calibrations will be performed within 30 days of the logging event. Before and after calibrations will be conducted for each logging tool run in the borehole. If necessary, a rat hole at the bottom of the borehole will be made to accommodate the logging tools(s) to ensure that the bottom zone can be evaluated.

A minimum of 100 feet of repeat log will be made after the initial down and up log, and a strip chart (hard copy) reviewed by the Shaw On-Site Representative. After completion of the borehole logging, a paper copy of the strip logs and digital logs on a compact disk will be reviewed by the On-Site Representative and placed in the project files and on the SharePoint site.

Electric Logging – Electric logs will consist of spontaneous potential, single-point resistance, and long and short normal resistivity. The span or sensitivity setting on each log processor will be noted on the respective strip chart title block.

Spontaneous potential logs will be recorded in millivolts per inch of chart paper. Single-point resistance logs will be recorded in ohms per inch of chart paper. Normal resistance logs will be both long (64-inch) and short (16-inch) normal logs. The length of the short and long normal logs will be stated in the respective strip chart title block.

Natural Gamma and Density Logging – Natural gamma and density (gamma-gamma) logging will be performed. The Shaw On-Site Representative will ensure the necessary containers and safeguards for the transportation, storage, and use of the nuclear source(s). The logging operator will be provide certification that they are properly trained and maintain the required licenses to handle the nuclear source(s). The logging operator will comply with all federal and state requirements for the use of active-source tools.

The gamma (natural radiation) measurement units, such as milliroentgens per hour, counts per second, inches of deflection, or standard units will be noted on the log scale. Pit calibration certificate(s) for the natural gamma and density tools will be placed on the SharePoint site and project file.

Caliper Logging – A standard 3- or 4-arm mechanical caliper log will be utilized. Before and after each borehole, the tool will be calibrated utilizing the appropriate standardized cylinder(s).

Geophysical Reporting – Three copies of the paper strip logs and an electronic (digital) log on compact disk will be provided for each boring at the completion of the downhole logging effort. Each log title block will include at a minimum the borehole number, probe type, module adjustments, logging speed, depth footage (vertical scale), horizontal units and scale, depth to groundwater and calibration(s).

3.6.5 Well Installation

After the deep borings have been drilled to the desired depth, the wells will be completed through the conductor casing. The shallow boring wells will be installed in an open boring. Depending on boring stability, the boring may need to be overdrilled to accommodate setting the well screen at the desired depth. If a rat hole

is required in the boring, sand may be placed in the bottom of the borehole to achieve the desired screened depth.

3.6.5.1 Well Screen and Casing

Well screens – Five-inch inside diameter (ID), threaded stainless-steel continuous wrap, 0.020 slot. It is anticipated that 20 feet of screen will be required for the deep monitoring wells and 10 feet of screen will be required for the shallow wells. Depending on the lithology encountered, the well screen may be longer or shorter than anticipated. A stainless-steel endcap will be placed on the bottom of the screen. Centralizers will be placed at the bottom and top of the well screen. If necessary, a collar will be required to transition the well casing from the stainless-steel screen to the casing.

Well casings – For the deep wells, 5-inch ID, flush-threaded steel casing or Schedule 80 poly-vinyl chloride (PVC) pipe will be attached to the top of the screen and extend to approximately 2 feet above the ground surface. Teflon® tape will be used on the screw joints to ensure a proper seal. The PVC pipe will be welded. For the shallow wells, 5-inch-ID Schedule 40 PVC casing will be used. The casing sections will be welded.

Decontamination – All well completion materials shall be decontaminated by steam (plus non-phosphorous detergent if solids, oil, or grease are observed) and rinsed prior to installation.

3.6.5.2 Filter Pack, Bentonite Seal, and Grout

Filter pack – Clean, inert, silica (noncarbonated) sand with less than 10 percent fines will be used to construct a uniform and continuous filter pack. The filter pack will be placed by tremie pipe from the bottom of the boring to approximately 5 feet above the top of the well screen. The exact placement of the sand pack will depend on the screen length.

Bentonite seal – A 5-foot-thick bentonite seal will be installed immediately above the filter pack. If the boring is dry at that depth, bentonite pellets will be tremied into the annular space between the riser and the borehole wall immediately above the sand pack and sufficiently hydrated with clean water to preclude transmission of grout from above into the sand pack or well screen. If the thickness of the water column above the well screen would hydrate the bentonite pellets before placement, at least 2 feet of fine sand will be tremied on top of the filter pack, followed by a tremied bentonite slurry. The

bentonite slurry will consist of approximately 1 bag of Quikgrout bentonite and 25 gallons water. Either type of bentonite seal will be allowed to set for a minimum of 10 hours before grout is added to the annular space.

Grout – Neat cement consisting of approximately 94 pounds portland Type II cement (in accordance with ASTM C-150), 5 pounds powdered bentonite, and 7 gallons of water will be used. The grout will be placed by tremie pipe from the top of the bentonite seal to the ground surface. The grout will be allowed to stand for 24 hours before completing the aboveground protective casing and apron. This time is required to allow the ground to adequately settle in the well annulus. Depending on the amount of settling, the grout may need to be topped off.

3.6.5.3 Surface Completion

To secure the well, a lockable metal lid will be attached to the top of the outer protective casing to protect the well casing. If necessary, the well protective casing will be welded to the conductor casing after the boring and/or monitoring well is completed. To prevent frost heave between the pad, outer casing and well casing, and ground surface, bentonite will be placed into the borehole annular space to the ground surface.

The concrete pad will be 4 feet square and approximately 2 inches thick. A weep hole (approximately 1/8-inch diameter) will be drilled in the protective casing at an elevation no more than 1 inch above the permanent concrete pad. The pad will be sloped away from the protective casing a minimum of 1 inch to the edge of the pad to provide positive drainage.

For wells installed in high-traffic areas, four 4-inch-diameter steel posts (painted yellow) extending approximately 3 feet above the pad will be installed around the concrete pad and set in concrete. Locks will be emplaced and a permanent marking or tag which clearly identifies the well will be affixed to the outer steel protective casing.

3.7 WELL DEVELOPMENT

Monitoring wells will be developed by surging the screened interval with a surge block and pumping to remove sediment. Each monitoring well will be developed no sooner than 48 hours after completion but no later than 7 days after completion. This may be supplemented by bailing and surging as necessary. Equipment inserted into any monitoring well shall be decontaminated before use.

The development method will allow for the controlled capture of the sediments and effluent water from the well. A piston bailer or other approved method will be used at the completion of development to remove sediment from the bottom of the well. Because all development waters will be assumed to potentially contain methane gas, it will be allowed to vent to the atmosphere.

A minimum of five times the well volume (saturated filter pack and standing water column) in each well will be removed during development. During monitoring well development, turbidity, pH, electrical conductivity, and temperature of the water will be measured at 30-minute intervals. Development of the monitoring wells will continue until water produced has a turbidity of no more than 10 nephelometric turbidity units. Field turbidity results will be reported on the final development log for each well.

Three successive parameter readings within 10 percent of each other will be used as criteria for proper well development in conjunction with the turbidity readings. If, after 10 hours of well development, the turbidity criteria cannot be met, EPA will be notified. EPA approval will be required for monitoring wells that cannot meet the well development criteria of 10 nephelometric turbidity units.

3.8 WELL ABANDONMENT

In the event a boring or well cannot be completed as desired, the borehole and/or well will be abandoned in accordance with Wyoming State Engineer requirements. EPA authorization will be required to abandon a completed or partially completed boring or monitoring well. Every reasonable effort will be made to remove the well casing and screen. Following removal, the borehole will be filled with grout and sealed at the surface.

3.9 SITE RESTORATION

Following installation of the surface completions, the top of well casing locations will be surveyed. Erosion and sediment control measures implemented will be removed, and the site restored to near pre-well installation conditions. As necessary, repairs will be made to damaged structures or pavement prior to demobilization. The areas around the decontamination pad, laydown areas, and waste accumulation areas, will be graded and seeded, if necessary.

3.10 WASTE MANAGEMENT, TRANSPORTATION, AND DISPOSAL

It is anticipated there will be three waste streams during drilling, installation, and development:

1. Solid waste in the form of drilling mud and cuttings
2. Aqueous liquid waste in the forms of well development groundwater, drilling fluids, and decontamination solutions (soapy water, steam condensate, etc.)
3. Solid waste in the form of domestic trash, used PPE, etc.

3.10.1 Drill Cuttings

For the deep borings, it is assumed that up to 20 cubic yards of drill cuttings will be produced per 800-foot by 10-inch borehole. Adding the drilling mud to this volume, it is assumed that each deep boring will produce 25 cubic yards of drill cuttings. If off-site disposal is required, three 10 cubic yard roll-offs will be needed per deep boring.

For the shallow borings, it is assumed that up to 4 cubic yards of drill cuttings will be produced per 250-foot by 8-inch-ID borehole. Adding the drilling mud to this volume, it is assumed that each shallow boring will produce 5 cubic yards of drill cuttings. If off-site disposal is required, one partially filled 10-cubic yard roll-off will be needed per shallow boring.

It is assumed that the cuttings will be nonhazardous. If off-site disposed is required, in a municipal landfill, the cuttings will have to be de-watered.

It is anticipated that disposal will be to the Sand Draw Municipal Landfill outside Riverton, Wyoming. The waste acceptance criteria for the landfill include a) no free liquids, and b) documented nonhazardous. The drill cuttings will be sampled and analyzed in a fixed-base laboratory for toxic characteristics by toxicity characteristic leaching procedure EPA Method 1311 followed by determinative analyses for Resource Conservation and Recovery Act-regulated toxic characteristic metals (8), toxic characteristic volatile organic compounds, and toxic characteristic semivolatile organic compounds. Additionally a paint filter test (EPA Method 9095) will be run on each sample to document that there are no free liquids. Details are presented in the QAPP. It

is anticipated that each container (such as a roll-off box) containing cuttings will have to be sampled separately.

3.10.2 Aqueous Wastes

The assumed volumes of water that will be generated during well development are 10,000 gallons per deep well and 3,000 gallons per shallow well. If the development water cannot be disposed of at the well site, it will be transported via water truck. Most water trucks have a 2,000-gallon capacity, so each deep well is expected to generate five to six truckloads, while each shallow well is expected to generate two truckloads.

Liquids that are relatively free of suspended sediment can be transported to and disposed of at the Riverton, Wyoming wastewater treatment plant. The plant has a National Pollutant Discharge Elimination System permit to discharge treated wastewater into the Wind River drainage but does not operate an Industrial Pretreatment Program for industrial or high volume dischargers. Consequently, there are no wastewater constituent criteria Shaw must demonstrate compliance with by sampling and analysis, with a couple of minor exceptions. The wastewater to be discharged must be within their allowable pH range of 6.5 to 8.5 standard units. Also, the treatment plant must be provided with a "compatibility" sample which they will test in their facility to ensure Shaw wastewater will not impact the bacteria in their treatment process. Details are presented in the QAPP.

3.10.3 Miscellaneous Solid Waste

During field activities, miscellaneous solid waste will be generated in the form of used PPE, domestic trash, etc. This will be collected and disposed of appropriately in accordance with local custom.

3.11 DOCUMENTATION

A daily field record of the operation of site activities, including boring and well installation activities and support activities such as equipment decontamination, will be kept on standardized forms. At a minimum, the following data shall be included in the daily reports:

- Dates and times of beginning and completion of work
- A list of personnel, including subcontractors, at the site and their

approximate work location

- The number and location of borings and monitoring wells worked on
- A list of major equipment on site and its location (borehole, monitoring well, or equipment decontamination location)
- Materials consumed such as screen and well casing
- Final boring and monitoring well completion depths and "as built" construction specification
- Downhole borings logged, included the types of logs and total footage logged
- Any problems encountered, including standby time recorded.

The records will be signed daily by the Shaw representative and the representative of the respective subcontractors on site.

3.12 DEMOBILIZATION

Upon completion of site restoration, Shaw will begin demobilization activities, which will include the following:

- Site cleanup
- Removal of all temporary facilities
- Decontamination and demobilization of construction equipment
- Demobilization of all personnel.

As part of Shaw's lessons learned program, all site personnel will be required to attend a project debriefing to identify project success, failures, and areas requiring improvement prior to leaving the site. Shaw personnel will demobilize from the site upon completion of all site activities. Prior to demobilizing from the site, the client representative will conduct a final inspection for site acceptance and approval.

3.13 POST-CONSTRUCTION REPORTS

This task includes the preparation and submittal of a Completion Report. The report will summarize the procedures used to carry out the work activities and will include analytical reports for all sampling and analyses, as-built drawings, disposal documentation, daily reports, and any challenges encountered along with corrective measures. A draft report

will be submitted for review and comment by EPA. Upon receiving comments, Shaw will address the comments and submit the report as the final submittal.